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AN ECONOMETRIC ANALYSIS OF THE U.S. APPLE INDUSTRY

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A dynamic national apple industry model is specified including relationships for bearing acres, production, utilization, and allocation to the fresh, canned, frozen, juice, dried and other markets. Demands in each of these markets are modeled. Model coefficients are obtained using Zellner's seemingly unrelated regression procedure and data from 1970 through 1990. Elasticities and flexibilities are compared with other studies. The model is used to project future production, utilization and prices under various industry scenarios of acreage, fresh exports and juice import prices.

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INTRODUCTION

Apples are grown in thirty-five of the fifty states in the nation. Nearly five hundred thousand acres are in commercial production yielding nearly ten billion pounds of fruit each year. This production is equivalent to over a billion dollars in revenue for the nation's apple growers (USDA). Ten states account for nearly 90 percent of the U.S. apple crop. Washington, New York and Michigan produce nearly 70 percent of the crop (Sparks et. al.) Apples are the most extensively grown deciduous fruit in the Northeast. More than 166,000 acres are in commercial production producing one-third of the nation's harvest (USDA LISA). Once produced, these apples are allocated to alternative product markets. Historically, the fresh market has claimed over fifty percent of the apple harvest. The processed market consists of those apples used for canning and freezing, juice, dried apples and other products.

The domestic apple industry has been faced with several economic issues over the past few years. Increased concern about chemicals used in the production process has affected the demand for the fruit. In 1989, the chemical alar was brought to national attention by a National Resources Defense Counsel report and the television program 60 Minutes. Alar was removed from the market and the apple industry launched a massive campaign to counteract the negative impacts of the publicity surrounding the issue.

In addition, the industry is faced with increasing juice imports. Since 1980, per capita juice imports have increased over twenty-five percent per year. Yet, per capita consumption of apple juice has increased less than six percent per year (USDA).

Furthermore, new apple varieties have been introduced. Some of these cultivars are disease resistant and would require less chemical applications, yet they do not have clear marketing channels. Encouraging growers to adopt these cultivars depends on the benefits associated with growing these varieties and the ability to market these varieties at roadside stands and to retail outlets.

One means of evaluating the potential impacts of changes in the apple industry and the profitability of the industry is to conceptualize a model of the industry, estimate that model, validate the model and use the model for analyzing alternative scenarios. Any model is a simplification of reality, yet it should capture the industry's key structural relationships. Model conceptualization would require an understanding of the industry structure as well as an understanding of the appropriate economic theory governing the decision making of the players in the industry. Consumer theory would be applicable in development of the demand for products. Firm theory would be the appropriate paradigm to use in the development of the supply of the products. Theory associated with market structure, and the role of competition should affect the modeler's development of the interaction of the supply and demand components of the model.

The objectives of this research are (1) to identify the factors affecting the supply and demand for U.S. apples, (2) to determine the degree of substitutability and complementarity of various apple products and (3) to estimate changes in domestic apple consumption, production and prices under various industry scenarios.

To achieve these objectives five steps were completed. First, data related to the apple industry were collected. These data, on acres, production, prices, utilization, imports and exports, are annual observations collected from secondary sources. Second, a model of the industry was conceptualized based upon the principles of economic theory. The model consists of three sectors. The supply sector includes relationships describing the acreage and production of apples. Equations in the allocation sector explicitly model the allocation of apple production to the fresh, canned, frozen, juice, dried and other markets. The demand sector includes demand equations derived from consumer utility theory for each product. Third, assumptions were made to prepare the model for econometric estimation. These assumptions relate to the characteristics of the individual equations, the characteristics of the error term, the relationships between the equations within a sector and the association between model sectors. The assumptions dictated the appropriate econometric technique used for model estimation. Model coefficients, their t ratios and equation statistics are presented. Model validation was completed in the fourth step. Model validation includes the evaluation of model coefficients and their associated t ratios, equation statistics, static and dynamic historical simulation and model forecasting for periods beyond the data set. Finally, simulation techniques were used to evaluate the impact of changes in acreage, fresh exports and juice import price on production, consumption and prices in the industry. In the simulations, population and income are assumed to increase at previous levels; yet, other exogenous variables are held constant. Several simulations were analyzed.

This report is organized as follows. The conceptual model of the national apple industry is presented in the next section. The development of each sector is based on relevant economic theory. The third section of this paper discusses the data used for analysis and the econometric estimation procedures. Coefficient estimates and elasticities and flexibilities are presented. Validation statistics for static and dynamic simulation are discussed. The next section of this paper identifies the potential impacts of changes in acreage, fresh exports and juice import price on the industry's production, allocation and utilization using simulation analyses. The final section of the paper includes a summary and conclusion.

STRUCTURAL MODEL

There have been several studies dealing with the apple industry. These studies date from an analysis of the production outlook of apples in Michigan in the mid-1950's (French) to the analysis of the demand for fresh apples in four import markets in the 1990's (Sparks et. al.). Tomek developed a supply-demand model of the industry using data from 1947 through 1966. The model included supply and demand equations for fresh apples, frozen and canned apples and other apple products. He used the model to forecast 1975 production, demand and prices. Hayward et. al. developed a model of the apple industry in Maine and the United States using data from 1960 through 1981. Their econometric model incorporates the rate of size-controlled tree adoption. Using data from 1952 through 1981, Baumes and Conway estimated an econometric model including demand, domestic market allocation, and margin equations for the fresh and processed market. Rae and Carman developed a detailed perennial crop supply model of the New Zealand apple industry using data from 1958 through 1972. In 1976, Piggott published an article comparing a perfectly competitive, monopolistic and quasi-monopolistic apple industry. Recently, Chaudry developed and estimated an econometric model of the industry that incorporates demand and allocation decision-making in various regions of the U.S. and during different time periods within the market year. He used data from 1959 through 1984 for his analysis. There have been other models of the apple industry that focus on interregional competition. Miller, Dunn and Garafola, and Fuchs et. al. are some examples.

Development of this structural model of the apple industry draws on the experience and results of other researchers. This model of the apple industry is composed of three sectors, the supply sector, the allocation sector and the demand sector. The supply sector includes relationships describing bearing acres, and yields per acre. Allocation of production is made to the fresh and processed markets. The processed product is then allocated to the canning, freezing, dried, juice and other product markets within the allocation sector. Demand functions for each of these products are specified in the demand sector. Net imports of all products are assumed to be exogenous with the exception of juice imports. The model includes an explicit relationship for this product. Functions relating the price of each product to the processed price and the average apple price are specified. Hence, the model of the industry presented here contributes to the research on the apple industry by providing a more detailed analysis of the allocation to various marketing outlets and the demand for these products. Furthermore, the model incorporates production of apples and the demand for juice imports in detail. Data used for model estimation covers a more recent period, 1970 through 1990, than previous studies. Each sector of the model will be discussed.

Supply Sector

Apples, a perennial crop, are produced by profit maximizing producers who are assumed to maximize the net revenue they receive from their outputs subject to the technical constraints imposed by their production function. Following the development of the perennial crop model by French and Matthews and French, King and Minami, the number of bearing acres in the current period is simply the number of bearing acres in the previous year less net removals in the current year as seen by

(1.0) $AB_t = AB_{t-1} - NR_t$,

where AB and NR represent bearing acreage and net removals of acreage, respectively.

Net removals are from new plantings (N) in previous years coming into production less the acreage removed (R) from the earlier season. This relationship can be expressed as

(2.0) $NR_t = N_{t-k} - R_{t-1}$.

In equation (2.0), k represents the length of time it takes apple acreage to become bearing. Acreage planted with standard cultivars can take as long as nine to ten years to come into full production. However, dwarf and semi-dwarf trees come into full production as early as four to five years following planting.

New plantings can be expressed as a function of the expected profitability (π^e) of the industry as seen in

(3.0) $N_{t-k} = f_3(\pi^e_{t-k}, \varepsilon_{3t-k})$.

Industry profitability is a function of the price received for apples (PAD) and the cost of producing these apples (COPD) as seen by

(4.0) $\pi_t = f_4(PAD_t, COPD_t, \varepsilon_{4t})$.

It is reasonable to assume that the profitability of alternative opportunities for the acreage, such as other agricultural products or housing developments (which is so prevalent in the Northeast region) may affect the number of new acreage planted. However, it is difficult to isolate all of the alternative opportunities that may be available to apple producers. Furthermore, these opportunities vary between region and over time.

A certain portion of bearing acreage is removed each year for reasons other than industry profitability. Acreage may be old and not producing to capacity or acreage could be removed periodically to make room for other crops or new apple plantings. Lagged bearing acreage is included in the following removal equation to capture this phenomenon. In addition, industry profitability plays a role in the number of removals. If profitability is high, some acreage may be kept in production even though its production is lower than desired. Hence the removal relationship is

$$(5.0) \qquad R_{t-1} = f_5(AB_{t-1}, \pi^e_{t-1}, \varepsilon_{5t-1}),$$

where variables are as defined previously.

Detailed data on removals, new plantings and age class of apples would allow for estimating relationships for new plantings, yields for each age class and removals of acreage. However, such detailed data are not often available. Hence, it is difficult to estimate econometrically these relationships. Substitution of equations (3.0) and (5.0) into equation (2.0), and equation (2.0) into equation (1.0) yields a new acreage relationship where bearing acreage is a function of lagged acreage, and measures of profitability. The function is

$$(6.0) \qquad AB_t = f_6(AB_{t-1}, \pi^e_{t-1}, \pi^e_{t-k}, \varepsilon_{6t}).$$

The error term in this equation is a composite of the random elements in the new plantings and the removals equations.

Apple yields vary by age of the acreage. Yields are low for the first few years, increase, level off and then decline as the acreage gets older. It would be desirable to have separate yield equations for each age class. However, it is not practical given data limitations. It does seem reasonable that yields are a function of expected apple profitability. If profitability is expected to increase, yields would expand. If profitability is expected to fall, yields may decrease. It is also reasonable that yields have increased over time due to technological advances in the production of apples. Hence, the relationship for apple yields is expressed as

$$(7.0) \qquad Y_t = f_7(\pi^e_t, T_t, \varepsilon_{7t}),$$

where T represents a time trend.

Once yields and bearing acreage are determined the total quantity of apples produced can be expressed as

$$(8.0) \qquad QPT_t = AB_t * Y_t,$$

where QPT is defined at the total quantity produced. Utilized production is a fraction of total production. All of the apples produced may not be harvested or discarded for economic or other reasons. Historically, this fraction has been 99 percent. Hence, utilized production (QPU) is defined as

(9.0) $QPU_t = 0.99 * QPT_t$.

In summary, the development of the supply sector of the model follows the perennial crop model developed by French and Matthews and French, King and Minami. This model is simplified due to data availability and ease of estimation. The final model specification consists of two stochastic equations, ((6.0) and (7.0)) for bearing acreage and yield and two non-stochastic equations ((8.0) and (9.0)) for total production and utilized production.

Allocation Sector

Once apples are produced, they are used in various markets. The domestic supply of apples is allocated to the fresh and processed markets. Model specification of allocation to various markets can be handled in a variety of ways. One alternative is to specify the actual quantity of a product allocated to a particular market as a function of the total supply and relative prices. Alternatively, the dependent variable could be the market share for that particular product. The market share, equivalent to the quantity allocated to a particular market divided by the total supply, is expressed as a function of the relative prices. Preliminary analyses of the data suggest the first specification is more appropriate for the apple industry. Hence, the allocation of apple production to the fresh market is determined by the total supply to be allocated and the expected relative prices in each market. The allocation of apples to the fresh market (QPUF) is expressed as

(10.0) $QPUF_t = f_{10}(QPU_t, PFD_t^e, PPD_t^e, \varepsilon_{10t})$.

If the total utilization of apples (QPU) were to increase, one would expect the fresh allocation to increase. An increase in the fresh price expected by producers (PFD) would increase the quantity allocated to the fresh market, all else equal. Since fresh apples can be diverted to processed markets, the expected average price of all processed apples (PPD) is included. An increase in this price would decrease the fresh allocation assuming no change in other variables.

The allocation of apples to the processed market (QPUP) is expressed algebraically as the remainder of that which did not go to the fresh market, as seen by

(11.0) $QPUP_t = QPU_t - QPUF_t$.

Processed apples can be diverted to five markets: canned, juice, dried, frozen and other. The predominant use of apples in the canning market is for apple sauce. However, apples are also used for pie fillings, apple butter and other canned products. Processed apples diverted to the juice market are used for apple juice, juice blends and for cider and vinegar. The dried market consists of those apples used for dried fruit. The frozen market includes apples used for frozen pies and other frozen products. The apples used in the other market are for products such as apple chips, apple breads, etc.

The allocation of apples to each processed market is a function of the total apples allocated to the processed market (QPUP) and the expected price of the product relative to the expected price of all processed products. If the total supply of apples to the processed market increased, more apples would be diverted to each processed outlet. If the expected price of a particular processed product increased relative to the average of all processed products, one would anticipate a larger quantity allocated to that particular market.

In the apple industry, juice is often the residual claimant of processed apples. However, nearly fifty percent of all processed apples are utilized for juice. Hence, for this model the quantity of processed apples utilized for juice is modeled explicitly. Frozen apples are assumed to be the residual since they claim a relatively small portion of the processed apple market. The allocation of apples to the canned (QPUC), juice (QPUJ), dried (QPUD) and other (QPUO) markets is expressed as

(12.0) $QPUC_t = f_{12}(QPUP_t, PCD^e_t, PPD^e_t, \varepsilon_{12t})$,

(13.0) $QPUJ_t = f_{13}(QPUP_t, PJD^e_t, PPD^e_t, \varepsilon_{13t})$,

(14.0) $QPUD_t = f_{14}(QPUP_t, PDD^e_t, PPD^e_t, \varepsilon_{14t})$, and

(15.0) $QPUO_t = f_{15}(QPUP_t, POD^e_t, PPD^e_t, \varepsilon_{15t})$

respectively. The allocation to the frozen market (QPUR) is equivalent to the total utilization of processed apples less the quantity allocated to each market as seen by

(16.0) $QPUR_t = QPUP_t - QPUC_t - QPUJ_t - QPUD_t - QPUO_t$.

Demand Sector

The final sector of the model identifies the demand for all apples in the United States. Consumer demand theory tells us that rational consumers maximize their utility subject to their budget constraint. It is this maximization that yields product demand functions. These functions can be expressed as price dependent functions of the quantity demanded, quantities of other products that are substitutes or complements, income and other variables that might shift the demand function. Alternatively, the demand functions can be expressed as quantity dependent functions of the price of the product, the prices of other products that are substitutes and complements, income and other demand shifters. Historically, demand functions have been expressed as price dependent functions because quantities have been assumed to be predetermined (Waugh).

In this model of the industry, the domestic demand for each apple product is expressed as a price dependent function of the per capita quantity of apples utilized in each market (QU--), income (PCED) and the per capita quantity of apples consumed in other markets (QU--) where -- refers to the market type with F, C, J, D, O, R referring to fresh, canned, juice, dried, other, and frozen respectively. In addition per capita quantities of other fruits, such as fresh oranges (QUFO) and orange juice (QUJO), hypothesized to be substitutes or complements, are included in the appropriate relationships. The demand relationships for each market are expressed as

(17.0) $PFD_t=f_{17}(QUF_t,QUC_t,QUJ_t, QUD_t, QUO_t, QUR_t, PCED_t, QUFO_t, \varepsilon_{17t})$,

(18.0) $PCD_t = f_{18}(QUF_t, QUC_t, QUJ_t, QUD_t, QUO_t, QUR_t, PCED_t, \varepsilon_{18t})$,

(19.0) $PJD_t = f_{19}(QUF_t,QUC_t,QUJ_t, QUD_t, QUO_t, QUR_t, PCED_t, QUJO_t, \varepsilon_{19t})$,

(20.0) $PDD_t = f_{20}(QUF_t, QUC_t, QUJ_t, QUD_t, QUO_t, QUR_t, PCED_t, \varepsilon_{20t})$,

(21.0) $POD_t = f_{21}(QUF_t, QUC_t, QUJ_t, QUD_t, QUO_t, QUR_t, PCED_t, \varepsilon_{21t})$, and

(22.0) $PRD_t = f_{22}(QUF_t, QUC_t, QUJ_t, QUD_t, QUO_t, QUR_t, PCED_t, \varepsilon_{22t})$.

Economic theory suggests an inverse relationship between the price and own quantity of each apple product. The coefficients on other quantities will depend on whether the goods are substitutes or complements. If the product is a substitute, the coefficient should be negative. If the product is a complement, the coefficient should be positive. If apple products are normal goods the coefficient on income (PCED) should be positive.

Pricing Relationships

Since the price of all processed products (PPD) determines the allocation of apples between the fresh and processed markets, a relationship is necessary for determining processed price. This price for all processing products is assumed to be a function of the price of each processed product as seen in

(23.0) $PPD_t = f_{23}(PCD_t, PJD_t, PDD_t, POD_t, PRD_t, \varepsilon_{23t})$,

where prices are defined previously. A positive sign is anticipated for each coefficient.

The price of all apple products (PAD) affects the bearing acreage. Hence, its specification is expressed as a function of the price in the fresh market (PFD) and the average processed price (PPD) as seen by

(24.0) $PAD_t = f_{24}(PFD_t, PPD_t, \varepsilon_{24t})$.

A positive sign is expected for each coefficient.

Imports

Apple juice imports have increased significantly during the last twenty years. Hence it is unreasonable to assume juice imports are exogenous and will remain stable following the period of study. A stochastic relationship identifying the quantity of juice imports was included in the model. This function is expressed as

(25.0) $NIJ_t = f_{25}(PIJD_t, QPUJ_t, POP_t, \varepsilon_{25t})$,

where NIJ represents per capita juice imports, PIJD is the juice import price, QPUJ is the total domestic allocation of apples to the juice market, and POP is population. As the per capita quantity of apples allocated to juice in the domestic market increases, one would expect a smaller quantity of juice imports. If the import price of juice increases, one would anticipate a decrease in the quantity of juice imports. Hence negative coefficients are anticipated for these variables.

Utilization

The final model equations describe total consumption, or utilization, of each apple product. Utilization depends on the domestic allocation to that market (QPU--) and the net imports (NI--) of that product type. Hence, the total consumption of each product (QU--), expressed in per capita terms, can be identified as

(26.0) $QUF_t = QPUF_t/POP_t + NIF_t$,

(27.0) $QUC_t = QPUC_t/POP_t + NIC_t$,

(28.0) $QUJ_t = QPUJ_t/POP_t + NIJ_t$,

(29.0) $QUD_t = QPUD_t/POP_t + NID_t$,

(30.0) $QUO_t = QPUO_t/POP_t + NIO_t$, and

(31.0) $QUR_t = QPUR_t/POP_t + NIR_t$.

EMPIRICAL MODEL ESTIMATION AND VALIDATION

Model estimation requires an analysis of the theoretical model, substitution for all expected variables in the model specification, examination of the error terms within each model sector and across model sectors, collection of data and determination of the estimation technique. Once the model is estimated, the purpose of performing model validation is to provide the user with confidence that the model is adequate even though any model is a simplification of reality. To achieve this, model coefficients can be evaluated and compared with hypothesized signs and magnitudes. Equation summary statistics, such as the R^2 and the Durbin Watson statistic can be analyzed. Elasticities, flexibilities and model statistics from static and dynamic deterministic simulations can be evaluated. All of these measures generate confidence that the model is adequate and can be a helpful tool in evaluating scenarios. In this section, model estimation and validation issues are discussed.

Expected Price Formation

The structural model of the apple industry includes several expected prices and profitability variables. Alternative specifications were considered for these expected variables. The most prevalent expectation theories used in economics are the adaptive expectations theory and the rational expectations theory. Adaptive expectations assumes that expected prices are formed each year based on the discrepancy between the previous period's actual price and the expectation in the previous period (Nerlove). Rational expectations assume decision makers form their expectations as predictions of the relevant economic structure (Muth). Hence, it is the complete economic structure that determines the expectations.

The rational expectations model was considered inappropriate for the apple industry since complete economic structure is not known by all industry participants. The assumption of rational expectations would require the use of the complete system for estimation of each equation that incorporates an expectation variable. This would lead to a rather complex estimation technique (Willett). A modification of the adaptive expectations theory is used in the specification of the empirical model used for estimation. For each expected price or profitability, the price or profitability from a previous period is substituted for the expectation variable.

Bearing acreage (equation (6.0)) is a function of expected profitability in the previous period due to removals and a function of expected profitability in the kth previous period due to new plantings. Expected profitability is substituted by the price received for apples and an index of costs of production from these periods. The data are used to determine the value of k. As mentioned earlier, k could be nine for conventional plantings or four for dwarf or semi-dwarf plantings.

The yield relationship (equation (7.0)) is also a function of expected profitability. Because price and costs of production are not known when yield is determined, the price and costs of production from the previous period are substituted for expected profitability.

Each allocation equation (equations (10.0), (12.0), (13.0), (14.0), and (15.0)) is a function of expected prices of the relevant product and the expected average price of all processed products. The current prices are not known when the allocation decisions are made. Hence, the prices from the previous period are used as proxies.

Data

Data for the analysis, obtained from U.S. Department of Agriculture sources, are for the period 1971 through 1990. This period of analysis is a more recent period than previous studies. Data are annual values and reflect the crop year (August to July). All data series and their sources are listed in Appendices A and B. All monetary values in the model are deflated by the gross national product deflator. All quantity variables in the demand sector are expressed in per capita terms.

Empirical Model Structure

All equations in the model are assumed to be linear in the parameters. The supply sector, identifying the bearing acres, yield, total production and utilized production, are usually known at the beginning of the crop year and are independent of the allocation of the product to alternative outlets. Furthermore the allocation of the products is independent of the demands for each product, the pricing relationships and the demand for juice imports. Consequently, each model sector was considered independent of the other model sectors in the estimation process. Hence, the model was estimated as a block recursive system.

In the supply sector, the random error terms of the bearing acreage and yield equations, equations (6.0) and (7.0) are likely to be related. The allocation sector's random error terms for equations (10.0) through (16.0) may be related to each other. Furthermore, the random error terms of the demand sector, equations (17.0) through (22.0), are assumed to be associated. Zellner's seemingly unrelated regression method (Kmenta) was chosen to estimate each model sector: supply, allocation, and demand.

Due to the independence of the pricing relationships, equations (23.0) and (24.0), they were estimated by ordinary least squares. The juice import function, equation (25.0), was also estimated by ordinary least squares. The demand for imports is assumed to be determined after the allocation of the processed product to the juice market occurs.

Empirical Estimates

Coefficients, associated t statistics and equation statistics for the equations are presented in Table 1. Equation numbers in Table 1 refer to the theoretical equation developed in this report's Structural Model section. Variable definitions can be found in Table 2. All equations are as previously specified with the following exceptions.

Data indicated that the average price of apples from the ninth previous period was the most significant determinant of bearing acreage. Costs of production were not significant. Hence, PAD_{t-9} was substituted for the profitability measure in equation (6.0).

Analysis of the data revealed a significant decrease in the quantity of apples allocated to the other market sector. To capture this effect, a trend variable was included in equation (15.0).

The estimation of the demand sector revealed some variables with insignificant coefficients and coefficients with incorrect signs. Because the model was going to be used for simulation into the future, the insignificant variables with incorrect signs were omitted from the equations. The demand for dried and other apples appeared to shift in 1973-74 and again in 1976-79 perhaps due to the changing nature of demand from the oil situation in these years. The quantities of other apple products and income were not significant in these equations. Hence, these quantities were eliminated and dummy variables were included to capture the shifts in the 1970's. The demand for canned and frozen apple products appeared to shift in 1973-74 but not in 1976-79. Perhaps the oil impacts of the early 1970's were more significant than the late 1970's impact. Dummy variables for 1973-74 were included as shifters in these demand equations.

Table 1

U.S. Apple Industry Model 1971 - 1990

SUPPLY

Bearing Acres

(6.1) $AB_t = -72.947 + 1.162\ AB_{t-1} + 0.680\ PAD_{t-9}$ $R^2 = 0.980$ $Dh = -0.041$

(-4.324) (31.720) (1.718)

Yield

(7.1) $Y_t = 10.326 + 0.373\ T_t + 0.366\ PAD_{t-1}$ $R^2 = 0.661$ $DW = 1.930$

(4.926) (6.064) (2.699)

Production and Utilization

(8.1) $QPT_t = AB_t * Y_t$

(9.1) $QPU_t = 0.99 * QPT_t$

ALLOCATION

Fresh

(10.1) $QPUF_t = 195.458 + 0.535\ QPU_t + 399.778\ PFD_{t-1}/PPD_{t-1}$ $R^2 = 0.950$ $DW = 1.358$

(0.625) (17.832) (0.233)

Processed

(11.1) $QPUP_t = QPU_t - QPUF_t$

Canned

(12.1) $QPUC_t = 512.339 + 0.154\ QPUP_t + 132.893\ PCD_{t-1}/PPD_{t-1}$ $R^2 = 0.567$ $DW = 1.850$

(3.574) (4.796) (1.461)

Juice

(13.1) $QPUJ_t = -1254.635 + 0.792\ QPUP_t + 261.920\ PJD_{t-1}/PPD_{t-1}$ $R^2 = 0.938$ $DW = 1.486$

(-6.087) (17.377) (1.584)

Table 1 (continued)

U.S. Apple Industry Model 1971 - 1990

Dried

(14.1) $QPUD_t = 16.134 + 0.050\ QPUP_t + 41.518\ PDD_{t-1}/PPD_{t-1}$ $R^2 = 0.417$ $DW = 1.109$
(0.264) (3.715) (1.035)

Other

(15.1) $QPUO_t = 16.735 + 0.038\ QPUP_t + 65.285\ POD_{t-1}/PPD_{t-1} - 8.927\ T_t$ $R^2 = 0.518$ $DW = 2.361$
(0.255) (2.109) (1.163) (-3.948)

Frozen

(16.1) $QPUR_t = QPUP_t - QPUC_t - QPUJ_t - QPUD_t - QPUO_t$

DEMAND

Fresh Demand

(17.1) $PFD_t = 8.612 - 1.485\ QUF_t - 0.761\ QUJ_t + 2.016\ QUD_t + 5.147\ QUO_t + 0.100\ PCED_t$ $R^2 = 0.841$ $DW = 1.869$
(1.036)(-5.915) (-4.122) (1.390) (2.553) (3.878)

Canned Demand

(18.1) $PCD_t = -62.601 - 3.430\ QUC_t - 11.870\ QUF_t - 9.895\ QUJ_t + 40.706\ QUD_t + 40.514\ QUO_t$ $R^2 = 0.900$ $DW = 2.214$
(-0.743)(-0.603) (-4.695) (-5.210) (2.812) (1.742)

$+ 1.247\ PCED_t + 71.259\ D734_t$
(4.739) (7.648)

Juice Demand

(19.1) $PJD_t = -95.133 - 10.619\ QUJ_t - 7.717\ QUF_t + 31.047\ QUD_t + 43.223\ QUO_t + 1.057\ PCED_t$ $R^2 = 0.754$ $DW = 2.321$
(-0.947) (-4.638) (-2.582) (1.943) (1.640) (3.348)

Table 1 (continued)

U.S. Apple Industry Model 1971 - 1990

Dried Demand

(20.1) $PDD_t = 131.035 - 30.003\ QUD_t + 94.489\ D734_t + 86.783\ D769_t$ $R^2 = 0.811$ DW = 1.798

(6.428) (-1.462) (6.430) (8.026)

Other Demand

(21.1) $POD_t = 129.510 - 53.447\ QUO_t + 71.881\ D734_t + 54.903\ D769_t$ $R^2 = 0.722$ DW = 2.083

(12.622) (-2.547) (6.585) (7.445)

Frozen Demand

(22.1) $PRD_t = -11.399 - 40.265\ QUR_t - 5.533\ QUF_t - 12.678\ QUJ_t - 68.112\ QUO_t + 1.236\ PCED_t$ $R^2 = 0.823$ DW = 2.133

(-0.105)(-2.068) (-1.788) (-4.705) (-2.099) (3.461)

$+ 119.421\ D734_t$

(8.750)

PRICE RELATIONSHIPS

Processing

(23.1) $PPD_t = -9.687 + 0.356\ PCD_t + 0.450\ PJD_t + 0.194\ PRD_t + 0.092\ PDD_t - 0.053\ POD_t$ $R^2 = 0.998$ DW = 2.574

(-4.961) (7.505) (8.401) (4.892) (2.536) (-1.684)

Average Price

(24.1) $PAD_t = 0.008 + 0.023\ PPD_t + 0.559\ PFD_t$ $R^2 = 0.994$ DW = 1.449

(0.029)(11.286) (19.397)

IMPORTS

Juice

(25.1) $NIJ_t = 3.410 - 2.468\ PIJD_t - 0.536\ QPUJ_t/POP_t + 0.746\ T_t$ $R^2 = 0.898$ DW = 1.296

(1.817)(-1.635) (-2.048) (8.158)

Table 1 (continued)
U.S. Apple Industry Model 1971 - 1990

UTILIZATION

Fresh

(26.1) $QUF_t = QPUF_t/POP_t + NIF_t$

Canned

(27.1) $QUC_t = QPUC_t/POP_t + NIC_t$

Juice

(28.1) $QUJ_t = QPUJ_t/POP_t + NIJ_t$

Dried

(29.1) $QUD_t = QPUD_t/POP_t + NID_t$

Other

(30.1) $QUO_t = QPUO_t/POP_t + NIO_t$

Frozen

(31.1) $QUR_t = QPUR_t/POP_t + NIR_t$

Table 2

U.S. Apple Industry Model Variable Definitions

AB	Bearing Acres	(thousand acres)
D734	Dummy Variable for 1973-74 (1971-72=0, 1973-74=1, 1974-88=0)	
D769	Dummy Variable for 1976-79 (1971-75=0, 1976-79=1, 1980-88=0)	
NIC	Net Imports - Canned	(pounds/person)
NID	Net Imports - Dried	(pounds/person)
NIF	Net Imports - Fresh	(pounds/person)
NIJ	Net Imports - Juice	(pounds/person)
NIO	Net Imports - Other	(pounds/person)
NIR	Net Imports - Frozen	(pounds/person)
PAD	Average Grower Price - All	(1982 cents/pound)
PCD	Average Grower Price - Canned	(1982 $/ton)
PCED	Personal Consumption Expenditure for Food	(billion 1982$)
PDD	Average Grower Price - Dried	(1982 $/ton)
PFD	Average Grower Price - Fresh	(1982 cents/pound)
PIJD	Average Price - Juice Imports	(1982 $/gallon)
PJD	Average Grower Price - Juice and Cider	(1982 $/ton)
POD	Average Grower Price - Other	(1982 $/ton)
POP	Population	(million)
PPD	Average Grower Price - Processing	(1982 $/ton)
PRD	Average Grower Price - Frozen	(1982 $/ton)
QPT	Total Production	(million pounds)
QPU	Utilized Production	(million pounds)
QPUC	Canned Utilization	(million pounds)
QPUD	Dried Utilization	(million pounds)
QPUF	Fresh Utilization	(million pounds)
QPUJ	Juice and Cider Utilization	(million pounds)
QPUO	Other Utilization	(million pounds)
QPUP	Processed Utilization	(million pounds)
QPUR	Frozen Utilization	(million pounds)
QUC	Per Capita Utilization with Net Imports - Canned	(pounds/person)
QUD	Per Capita Utilization with Net Imports - Dry	(pounds/person)
QUF	Per Capita Utilization with Net Imports - Fresh	(pounds/person)
QUJ	Per Capita Utilization with Net Imports - Juice	(pounds/person)
QUO	Per Capita Utilization with Net Imports - Other	(pounds/person)
QUR	Per Capita Utilization with Net Imports - Frozen	(pounds/person)
T	Time Trend	(1971=1)
Y	Yield	(thousand pounds/acre)

All model equations, seen in Table 1, have coefficients consistent with the hypothesized signs and of reasonable magnitudes with the exception of equation (23.1). Variable t statistics are significant. Equation R^2's are reasonable and equation Durbin Watson statistics indicate either no autocorrelation or are inconclusive. In equation (23.1), an increase in the price of other apple products yields a decrease in the average price for all processing products. This phenomenon could be due to a reduction in the allocation of apples to the other market over the length of the sample.

Elasticities and Flexibilities

Demand and supply elasticities evaluated at the mean of the data set and at 1990, the last period in the data set, are presented in Table 3. The acreage elasticity ($\varepsilon_{AB_t\ PAD_{t-9}}$) indicates that the response of apple acreage to the changes in all apple prices is inelastic. Elasticities of supply, reflected by the allocation elasticities, are inelastic for all products when evaluated at the mean. Changes in these prices will generate a smaller percentage change in the quantity of apples allocated to each market. The fresh allocation elasticity ($\varepsilon_{QPUF_t\ PFD_{t-1}}$) is nearly zero when evaluated at the mean and 1990 values, supporting the notion that fresh supplies are largely pre-determined. The other product elasticity ($\varepsilon_{QPUO_t\ POD_{t-1}}$) is very inelastic when evaluated at the mean but elastic when evaluated at 1990 values. The change in elasticities reflects the large increase in the quantity of apples allocated to the other product market during the sample period. All supply elasticities are consistent with those found by Tomek.

Demand flexibilities, seen in Table 3, suggest the demands for fresh apples ($f_{PFD_t\ QUF_t}$) and apple juice ($f_{PJD_t\ QUJ_t}$) are inelastic. The demand for canned ($f_{PCD_t\ QUC_t}$), dried ($f_{PDD_t\ QUD_t}$), frozen ($f_{PRD_t\ QUR_t}$), and other apples ($f_{POD_t\ QUO_t}$) are elastic. French found the elasticity for all apples to be -1.19. Tomek estimated the own price elasticities for fresh, canned and other apples to be -0.81, -1.21 and -0.76 respectively. Huang estimated fresh apple demand to be inelastic with a measure of -0.20. Baumes and Conway found flexibilities for fresh and processed apples to be -0.36 and -0.69, respectively. Hayward et. al.'s estimate of the flexibility for all apples was -1.59. Miller's price elasticity for national apple demand was -0.59. While there is some variation among the elasticity and flexibility measures, those estimated in this study are within the range of other studies.

Table 3
Elasticities and Flexibilities for U.S. Apple Industry Model

		Mean	1990 Values
Supply Sector			
Bearing Acres	$\varepsilon_{AB_t\,PAD_{t-9}}$	0.021	0.017
Yield	$\varepsilon_{Y_t\,PAD_{t-1}}$	0.235	0.151
Allocation			
Fresh	$\varepsilon_{QPUF_t\,PFD_{t-1}}$	0.012	0.009
Canned	$\varepsilon_{QPUC_t\,PCD_{t-1}}$	0.128	0.126
Juice	$\varepsilon_{QPUJ_t\,PJD_{t-1}}$	0.131	0.093
Dried	$\varepsilon_{QPUD_t\,PDD_{t-1}}$	0.186	0.142
Other	$\varepsilon_{QPUO_t\,POD_{t-1}}$	0.099	1.185
Demand			
Fresh	$f_{PFD_t\,QUF_t}$	-1.650	-1.850
	$f_{PFD_t\,QUJ_t}$	-0.584	-0.962
	$f_{PFD_t\,QUD_t}$	0.121	0.105
	$f_{PFD_t\,QUO_t}$	0.154	0.088
	$f_{PFD_t\,PCED_t}$	2.430	2.870
Canned	$f_{PCD_t\,QUC_t}$	-0.125	-0.151
	$f_{PCD_t\,QUF_t}$	-1.499	-1.862
	$f_{PCD_t\,QUJ_t}$	-0.863	-1.575
	$f_{PCD_t\,QUD_t}$	0.279	0.268
	$f_{PCD_t\,QUO_t}$	0.137	0.087
	$f_{PCD_t\,PCED_t}$	3.456	4.520
Juice	$f_{PJD_t\,QUJ_t}$	-1.278	-2.398
	$f_{PJD_t\,QUF_t}$	-1.345	-1.717
	$f_{PJD_t\,QUD_t}$	0.293	0.290
	$f_{PJD_t\,QUO_t}$	0.202	0.131
	$f_{PJD_t\,PCED_t}$	4.042	5.435
Dried	$f_{PDD_t\,QUD_t}$	-0.230	-0.262
Other	$f_{POD_t\,QUO_t}$	-0.214	-0.133
Frozen	$f_{PRD_t\,QUR_t}$	-0.231	-0.373
	$f_{PRD_t\,QUF_t}$	-0.617	-0.833
	$f_{PRD_t\,QUJ_t}$	-0.976	-1.936
	$f_{PRD_t\,QUO_t}$	-0.204	-0.140
	$f_{PRD_t\,PCED_t}$	3.025	4.298
Imports			
Juice	$\varepsilon_{NIJ_t\,PIJD_t}$	-0.378	-0.117

Fresh, canned, juice and frozen apples are normal goods as indicated by their income flexibilities ($f_{PFD_t\ PCED_t}$, $f_{PCD_t\ PCED_t}$, $f_{PJD_t\ PCED_t}$, $f_{PRD_t\ PCED_t}$). Huang estimated the expenditure elasticity to be -0.35 implying an inferior good.

Cross-price flexibilities estimated with this study suggest that fresh apples and apple juice ($f_{PFD_t\ QUJ_t}$ and $f_{PJD_t\ QUF_t}$) are substitutes. Yet, fresh apples and dried apples ($f_{PFD_t\ QUD_t}$), fresh apples and other apple products ($f_{PFD_t\ QUO_t}$), juice and dried apples ($f_{PJD_t\ QUD_t}$), and juice and other apple products ($f_{PJD_t\ QUO_t}$) are complements. Fresh apples and juice are substitutes for canned apples ($f_{PCD_t\ QUF_t}$, $f_{PCD_t\ QUJ_t}$), while dried apples and other apple products are complements for canned apples ($f_{PCD_t\ QUD_t}$, $f_{PCD_t\ QUO_t}$). Fresh apples, juice, and other apple products are substitutes for-frozen apple products ($f_{PRD_t\ QUF_t}$, $f_{PRD_t\ QUJ_t}$, $f_{PRD_t\ QUO_t}$). Tomek found other processed apples to be substitutes for fresh apples and for canning apples.

Static and Dynamic Simulation

Simulation, another method used to gain confidence in a model, places each endogenous variable only once on the left hand side of an equation. The right hand side variables must be exogenous variables, lagged endogenous variables or other endogenous variables that have been determined by a previous equation. In static, or one-period ahead, simulations the model computes the predicted values of current endogenous variables each period using the actual values of lagged endogenous variables. The dynamic simulation differs from the static simulation in that after the initial period, the model's predicted values of lagged endogenous variables are used to generate future values of the endogenous variables (Kost). Kost suggests evaluating simulation errors and inequality coefficients among other goodness-of-fit measures. Simulation errors, the measure of the deviation of the simulated variables from the true path of the variable, can be evaluated with various goodness of fit measures. These statistics are presented in Table 4.

As one might expect, the statistics indicate more error appears in the dynamic simulation. This phenomenon is due to the simulation using the predicted values of lagged endogenous variables each period rather than the actual values of lagged endogenous variables. The quantity of other apple products (QPUO), price of juice (PJD) and net imports of juice (NIJ) have large error statistics. Each of these variables had wide fluctuations during the sample period. So it is not unreasonable that the model's ability to simulate these values is not as accurate as for other variables.

Table 4

Static and Dynamic Simulation of the U.S. Apple Industry Model

Static Simulation[1]

	DATA MEAN	MODEL MEAN	ME	MAE	RMSE	MPE	MARE	RMSPE	U	U1	U2
AB	423.1	423.0	-0.19	3.19	3.74	-0.0004	0.0075	0.0088	0.0044	0.1880	0.3773
Y	18.6	18.6	0.00	1.05	1.28	0.0044	0.0562	0.0671	0.0342	0.2950	0.5584
QPT	7912.4	7908.8	-3.52	439.46	559.12	0.0041	0.0557	0.0686	0.0349	0.3113	0.5839
QPUF	4441.3	4439.4	-1.91	234.19	283.71	0.0044	0.0536	0.0650	0.0316	0.3399	0.6663
QPUP	3393.3	3390.4	-2.94	251.59	316.84	0.0067	0.0716	0.0858	0.0460	0.3446	0.6336
QPUC	1191.2	1189.7	-1.55	74.96	92.20	0.0057	0.0658	0.0826	0.0386	0.3845	0.6701
QPUJ	1649.1	1646.0	-3.10	260.91	312.59	0.0309	0.1637	0.1990	0.0913	0.3678	0.6737
QPUD	228.5	228.1	-0.44	28.72	34.99	0.0394	0.1498	0.2273	0.0755	0.4089	0.7190
QPUO	109.86	110.45	0.59	22.00	28.34	0.0689	0.2019	0.2446	0.1231	0.3663	0.6401
QPUR	214.6	216.1	1.55	34.12	38.91	0.0414	0.1654	0.1892	0.0889	0.5014	0.9500
PFD	16.31	16.45	0.14	2.43	2.85	0.0317	0.1542	0.1824	0.0859	0.4443	0.8926
PCD	143.51	143.65	0.14	23.75	28.80	0.0401	0.1701	0.2112	0.0971	0.3052	0.5850
PJD	104.00	104.24	0.23	23.79	29.93	0.0712	0.2424	0.3175	0.1376	0.4102	0.8293
PDD	128.36	128.37	0.00	16.85	19.98	0.0366	0.1550	0.2131	0.0737	0.2520	0.4859
POD	121.68	121.55	-0.13	13.28	18.22	0.0211	0.1071	0.1461	0.0728	0.2477	0.4210
PRD	162.49	162.19	-0.30	22.00	28.11	0.0287	0.1334	0.1707	0.0832	0.2489	0.4498
PPD	125.07	125.32	0.25	22.25	27.84	0.0520	0.1864	0.2429	0.1067	0.3255	0.6149
PAD	11.99	12.06	0.07	1.75	2.15	0.0338	0.1517	0.1913	0.0877	0.4094	0.8177
NIJ	5.39	5.39	0.00	1.16	1.41	0.0235	0.4423	0.7018	0.1053	0.3602	0.6765

1 ME = Mean Error, MAE = Mean Absolute Error, RMSE = Root Mean Square Error, MPE = Mean Percentage Error, MARE = Mean Absolute Relative Error, RMSPE = Root Mean Square Percentage Error, U = Theil's U Statistic, U1 = Theil's U1 Statistic, U2 = Theil's U2 Statistic.

Table 4 (continued)

Static and Dynamic Simulation of the U.S. Apple Industry Model

Dynamic Simulation[1]

	DATA MEAN	MODEL MEAN	ME	MAE	RMSE	MPE	MARE	RMSPE	U	U1	U2
AB	423.1	443.5	20.34	20.37	24.13	0.0465	0.0466	0.0538	0.0278	0.6095	2.9411
Y	18.6	18.5	-0.16	1.16	1.43	-0.0027	0.0619	0.0741	0.0384	0.3997	0.6712
QPT	7912.4	8243.4	331.01	646.45	752.40	0.0437	0.0811	0.0926	0.0459	0.4068	0.8028
QPUF	4441.3	4615.3	173.99	283.66	363.41	0.0411	0.0649	0.0831	0.0396	0.4029	0.8426
QPUP	3393.3	3545.7	152.34	324.56	395.99	0.0496	0.0932	0.1099	0.0562	0.4307	0.8318
QPUC	1191.2	1211.4	20.13	82.75	103.52	0.0240	0.0736	0.0954	0.0429	0.4317	0.7605
QPUJ	1649.1	1772.1	122.91	293.32	364.74	0.0992	0.1829	0.2195	0.1022	0.4444	0.8548
QPUD	228.5	237.0	8.43	30.79	37.20	0.0751	0.1613	0.2361	0.0786	0.4401	0.7638
QPUO	109.9	117.3	7.46	25.14	31.73	0.1570	0.2581	0.3395	0.1344	0.4075	0.7168
QPUR	214.6	208.0	-6.59	39.24	46.72	0.0085	0.1802	0.2064	0.1089	0.5925	1.1695
PFD	16.3	15.4	-0.92	2.45	2.97	-0.0405	0.1525	0.1864	0.0921	0.5069	0.9874
PCD	143.5	134.8	-8.67	23.50	29.47	-0.0324	0.1701	0.2202	0.1018	0.3239	0.6029
PJD	104.0	98.3	-5.66	21.16	29.24	-0.0022	0.2128	0.3045	0.1375	0.4224	0.8343
PDD	128.4	127.3	-1.10	16.42	19.77	0.0250	0.1488	0.2067	0.0731	0.2561	0.4905
POD	121.7	120.0	-1.67	12.87	18.02	0.0071	0.1020	0.1403	0.0725	0.2476	0.4194
PRD	162.5	154.4	-8.06	22.32	29.50	-0.0282	0.1353	0.1760	0.0889	0.2632	0.4732
PPD	125.1	118.0	-7.06	20.95	27.90	-0.0214	0.1757	0.2411	0.1093	0.3394	0.6274
PAD	12.0	11.3	-0.68	1.81	2.22	-0.0387	0.1543	0.1940	0.0931	0.4614	0.8969
NIJ	5.4	5.1	-0.28	1.26	1.48	-0.0569	0.4599	0.6762	0.1131	0.4426	0.8018

1 ME = Mean Error, MAE = Mean Absolute Error, RMSE = Root Mean Square Error, MPE = Mean Percentage Error, MARE = Mean Absolute Relative Error, RMSPE = Root Mean Square Percentage Error, U = Theil's U Statistic, U1 = Theil's U1 Statistic, U2 = Theil's U2 Statistic.

SIMULATION ANALYSIS

A common means of analyzing the impacts of exogenous changes on the performance of an industry is through the use of simulation analysis (French and Willett, Nuckton, French and King). The user can determine the impacts of individual changes on the industry with a series of simulations that isolate the changes. The econometric model developed here is used to project the impacts of changes in the apple industry on acreage, production, utilization and prices of apple products. The analysis is performed by dynamic deterministic simulation. Several scenarios are analyzed.

Simulation Assumptions

First, a base case is established. In the base projections, it is assumed that (1) population continues to increase at a rate of 1.02 percent per year, the average growth rate for the last five years of the data set, (2) income increases at a rate of 1.01 percent per year, the average growth rate for the last five years of the data set, (3) net imports of fresh, canned, dried, frozen and other apple products remain at their 1990 levels, and (4) any long term changes in the industry reflected by trend variables in the model continue for the duration of the analysis. The model is allowed to determine the acreage, yields, quantities produced and allocated to each apple product, the prices of the apple products and the net imports of juice products. The base case is used as a means of comparison with other simulations. It provides a benchmark if there were no other changes in the industry.

The second scenario maintains the assumptions of the base case. However, the acreage devoted to apples is held at 1990 levels. Historically, apple bearing acreage decreased until 1975 when it reached a low of 395.6 thousand acres. Since that time acreage increased an average of 1.5 percent per year. It is questionable if bearing acreage will or can continue to increase at that rate in the future. Hence for this scenario, the impacts of no growth in bearing acreage are analyzed.

In the third scenario, the per capita level of fresh exports is assumed to increase by 10 percent in 1991. This assumption is coupled with the four assumptions of the base case. The impacts of an increase in fresh apple exports, from 2.270 pounds per person in 1990 to 2.497 pounds per person in 1991 and subsequent years, on apple production, utilization and prices of apple products are analyzed.

The fourth scenario maintains the assumptions of the base case with the additional assumption of a ten percent decrease in the price of juice imports in 1991. In 1991, the deflated import price of juice decreases from $.559 per gallon to $.503 per gallon. This decrease in juice price follows the general trend of the per unit value of juice imports since 1979. In 1979 juice imports reached a peak price of $1.28 per gallon. Since that time the price has decreased an average of 5.1 percent per year.

The fifth scenario combines the assumptions of the base case with acreage held constant and the per capita quantity of fresh exports increasing 10 percent in 1991. In the sixth scenario acreage is held at 1990 levels, the price of juice imports decreases 10 percent in 1991 and the assumptions of the base case are maintained. The seventh scenario continues the assumptions of the base case and assumes that the per capita quantity of fresh exports increases 10 percent in 1991 and the price of imported juice decreases 10 percent in 1991. The final scenario is a combination of all previous scenarios. The base case assumptions are coupled with acreage held at 1990 levels, a 10 percent increase in per capita fresh exports in 1991, and a 10 percent decrease in juice import prices in 1991.

The 1990 historical value of selected model variables and five year projections, resulting from each of these scenarios, are presented in Table 5.

Simulation 1: Population and Income

The base projections indicate an increase in bearing acres (AB) from 485.5 thousand acres in 1990 to 573.9 thousand acres in 1995, an increase of 3.6 percent per year. Yield (Y) per acre varies between 20.0 and 22.0 thousand pounds per acre. Total apple production (QPT) appears to be cyclical with increases in 1991, 1993 and 1995. However, apple production follows an increasing trend. Recall that the model specification states that bearing acreage is a function of prices from nine years earlier and that yield and the allocation of the production to each product market is a function of the previous year's price. The fluctuation in yields and total apple production is generated by the lags inherent in the system. Hence, when prices are high, more apples are produced and allocated to the various markets. This decreases the market price. The low price is the signal for the next period's production and the cycle continues.

Table 5

Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	1	2	3	4	5	6	7	8
	Population Income	Population Income Acreage	Population Income Fresh Exports	Population Income Import Price	Population Income Acreage Fresh Exports	Population Income Acreage Import Price	Population Income Fresh Exports Import Price	Population Income Acreage Fresh Exports Import Price
Variables								
AB								
1990	485.5	485.5	485.5	485.5	485.5	485.5	485.5	485.5
1991	498.0	485.5	498.0	498.0	485.5	485.5	498.0	485.5
1992	512.6	485.5	512.6	512.6	485.5	485.5	512.6	485.5
1993	529.7	485.5	529.7	529.7	485.5	485.5	529.7	485.5
1994	549.8	485.5	549.8	549.8	485.5	485.5	549.8	485.5
1995	573.9	485.5	573.9	573.9	485.5	485.5	573.9	485.5
Y								
1990	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
1991	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
1992	20.2	20.4	20.3	20.2	20.5	20.4	20.3	20.5
1993	21.4	21.6	21.4	21.4	21.7	21.6	21.4	21.7
1994	20.5	21.1	20.5	20.4	21.1	21.0	20.5	21.1
1995	21.0	21.6	21.0	21.0	21.7	21.6	21.0	21.7
QPT								
1990	9696.8	9696.8	9696.8	9696.8	9696.8	9696.8	9696.8	9696.8
1991	10937.2	10662.6	10937.2	10937.2	10662.6	10662.6	10937.2	10662.6
1992	10361.0	9921.0	10404.9	10343.6	9962.6	9904.6	10387.5	9946.1
1993	11311.0	10500.1	11321.3	11312.9	10513.0	10499.5	11322.3	10511.8
1994	11243.6	10231.7	11287.3	11223.5	10268.4	10215.6	11267.9	10252.7
1995	12031.8	10503.1	12049.4	12031.0	10524.4	10497.7	12047.5	10518.5

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991
Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

Table 5 (continued)

Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	1	2	3	4	5	6	7	8
	Population Income	Population Income Acreage	Population Income Fresh Exports	Population Income Import Price	Population Income Acreage Fresh Exports	Population Income Acreage Import Price	Population Income Fresh Exports Import Price	Population Income Acreage Fresh Exports Import Price
Variables								
QPUF								
1990	5551.0	5551.0	5551.0	5551.0	5551.0	5551.0	5551.0	5551.0
1991	6048.5	5903.0	6048.5	6048.5	5903.0	5903.0	6048.5	5903.0
1992	5752.1	5518.0	5775.3	5744.0	5540.0	5510.2	5767.1	5532.2
1993	6248.8	5819.1	6254.5	6250.3	5826.1	5819.2	6255.5	5825.9
1994	6213.5	5676.6	6236.8	6203.7	5696.3	5668.7	6227.3	5688.5
1995	6628.3	5818.4	6637.9	6628.4	5829.9	5816.0	6637.4	5827.2
QPUP								
1990	4107.2	4107.2	4107.2	4107.2	4107.2	4107.2	4107.2	4107.2
1991	4779.4	4653.0	4779.4	4779.4	4653.0	4653.0	4779.4	4653.0
1992	4505.3	4303.9	4525.5	4496.2	4323.0	4295.3	4516.5	4314.5
1993	4949.1	4576.0	4953.6	4949.6	4581.7	4575.3	4953.6	4580.7
1994	4917.6	4452.7	4937.6	4907.6	4469.5	4444.7	4927.9	4461.7
1995	5283.2	4579.7	5291.0	5282.3	4589.3	4576.7	5289.6	4586.1
QPUC								
1990	1395.8	1395.8	1395.8	1395.8	1395.8	1395.8	1395.8	1395.8
1991	1407.1	1387.6	1407.1	1407.1	1387.6	1387.6	1407.1	1387.6
1992	1378.9	1346.7	1382.3	1378.9	1350.0	1346.7	1382.4	1349.8
1993	1444.0	1385.7	1445.0	1444.9	1386.8	1386.2	1445.7	1387.3
1994	1437.7	1364.8	1441.2	1437.2	1367.7	1364.3	1440.7	1367.3
1995	1493.2	1383.3	1494.7	1493.9	1385.0	1383.5	1495.3	1385.2

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991

Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

Table 5 (continued)

Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	**1** Population Income	**2** Population Income Acreage	**3** Population Income Fresh Exports	**4** Population Income Import Price	**5** Population Income Acreage Fresh Exports	**6** Population Income Acreage Import Price	**7** Population Income Fresh Exports Import Price	**8** Population Income Acreage Fresh Exports Import Price
Variables								
QPUJ								
1990	2075.8	2075.8	2075.8	2075.8	2075.8	2075.8	2075.8	2075.8
1991	2751.1	2651.0	2751.1	2751.1	2651.0	2651.0	2751.1	2651.0
1992	2484.1	2328.7	2502.2	2474.4	2345.6	2319.8	2492.7	2336.9
1993	2871.3	2573.6	2873.9	2871.8	2577.6	2573.0	2874.0	2576.7
1994	2824.1	2461.4	2841.4	2814.4	2475.6	2453.8	2832.0	2468.2
1995	3131.2	2572.0	3137.0	3130.3	2579.6	2569.2	3135.7	2576.6
QPUD								
1990	260.3	260.3	260.3	260.3	260.3	260.3	260.3	260.3
1991	292.4	286.1	292.4	292.4	286.1	286.1	292.4	286.1
1992	318.1	301.2	316.5	319.8	299.9	302.5	318.0	301.1
1993	310.5	289.3	310.8	310.7	289.4	289.4	310.9	289.6
1994	326.0	291.3	325.3	327.0	291.0	291.8	326.2	291.5
1995	331.4	289.9	331.5	331.7	289.0	289.1	331.8	289.2
QPUO								
1990	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0
1991	77.4	72.9	77.4	77.4	72.9	72.9	77.4	72.9
1992	133.7	114.7	129.8	137.0	111.5	117.4	132.9	114.0
1993	91.6	75.3	92.2	91.4	75.7	75.3	92.1	75.7
1994	125.4	89.4	123.0	127.7	88.1	90.7	125.1	89.3
1995	112.2	77.0	112.4	112.4	76.9	77.3	112.6	77.2

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991
Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

Table 5 (continued)

Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	1	2	3	4	5	6	7	8
	Population Income	Population Income Acreage	Population Income Fresh Exports	Population Income Import Price	Population Income Acreage Fresh Exports	Population Income Acreage Import Price	Population Income Fresh Exports Import Price	Population Income Acreage Fresh Exports Import Price
Variables								
QPUR								
1990	306.3	306.3	306.3	306.3	306.3	306.3	306.3	306.3
1991	251.3	255.4	251.3	251.3	255.4	255.4	251.3	255.4
1992	190.5	212.6	194.8	186.0	216.0	209.0	190.6	212.6
1993	231.6	252.2	231.7	230.8	252.3	251.3	230.8	251.4
1994	204.3	245.9	206.6	201.0	247.0	244.1	203.8	245.4
1995	215.1	258.5	215.4	214.0	258.8	257.6	214.2	257.9
PFD								
1990	15.89	15.89	15.89	15.89	15.89	15.89	15.89	15.89
1991	9.58	10.42	9.91	9.47	10.76	10.32	9.81	10.66
1992	13.81	14.87	13.90	13.85	14.98	14.88	13.93	14.99
1993	10.34	12.71	10.65	10.22	13.01	12.61	10.54	12.91
1994	12.22	14.77	12.35	12.23	14.95	14.75	12.36	14.93
1995	10.09	14.37	10.37	9.99	14.63	14.29	10.27	14.55
PCD								
1990	126.24	126.24	126.24	126.24	126.24	126.24	126.24	126.24
1991	72.23	79.36	74.93	70.87	82.06	80.00	73.56	80.69
1992	112.81	121.16	113.19	112.78	121.80	120.95	113.10	121.54
1993	83.07	102.90	85.57	81.62	105.27	101.56	84.16	103.96
1994	102.11	122.78	102.92	101.88	124.06	122.20	102.62	123.44
1995	85.09	120.61	87.27	83.79	122.63	119.48	86.02	121.52

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991
Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

Table 5 (continued)

Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	1	2	3	4	5	6	7	8
	Population Income	Population Income Acreage	Population Income Fresh Exports	Population Income Import Price	Population Income Acreage Fresh Exports	Population Income Acreage Import Price	Population Income Fresh Exports Import Price	Population Income Acreage Fresh Exports Import Price
Variables								
PJD								
1990	88.97	88.97	88.97	88.97	88.97	88.97	88.97	88.97
1991	36.17	40.98	37.92	34.70	42.73	39.52	36.45	41.27
1992	69.62	74.39	69.47	69.34	74.48	73.93	69.13	73.98
1993	46.15	59.33	47.81	44.62	60.88	57.89	46.31	59.46
1994	62.42	75.00	62.68	61.92	75.66	74.19	62.12	74.82
1995	49.95	73.24	51.35	48.56	74.51	71.98	50.00	73.26
PDD								
1990	95.06	95.06	95.06	95.06	95.06	95.06	95.06	95.06
1991	102.65	103.40	102.65	102.65	103.40	103.40	102.65	103.40
1992	100.00	101.98	100.19	99.81	102.13	101.83	100.02	101.98
1993	101.25	103.71	101.23	101.24	103.69	103.70	101.21	103.67
1994	99.84	103.82	99.93	99.73	103.85	103.76	99.82	103.80
1995	99.61	104.43	99.60	99.58	104.42	104.41	99.57	104.39
POD								
1990	108.75	108.75	108.75	108.75	108.75	108.75	108.75	108.75
1991	113.44	114.40	113.44	113.44	114.40	114.40	113.44	114.40
1992	101.89	105.85	102.70	101.19	106.50	105.29	102.05	105.98
1993	110.85	114.20	110.72	110.88	114.13	114.20	110.74	114.12
1994	104.13	111.48	104.62	103.67	111.75	111.21	104.19	111.50
1995	107.06	114.18	107.03	107.02	114.20	114.10	106.98	114.13

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991
Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

Table 5 (continued)

Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Population Income	Population Income Acreage	Population Income Fresh Exports	Population Income Import Price	Population Income Acreage Fresh Exports	Population Income Acreage Import Price	Population Income Fresh Exports Import Price	Population Income Acreage Fresh Exports Import Price
Variables								
PRD								
1990	131.56	131.56	131.56	131.56	131.56	131.56	131.56	131.56
1991	101.65	107.72	102.91	99.90	108.97	105.96	101.15	107.22
1992	117.13	127.32	117.82	115.58	128.01	125.78	116.30	126.49
1993	110.72	127.74	111.63	109.10	128.64	126.13	110.02	127.03
1994	116.44	138.89	117.07	114.97	139.58	137.41	115.61	138.09
1995	111.25	143.08	112.09	109.64	143.91	141.49	110.49	142.33
PPD								
1990	105.70	105.70	105.70	105.70	105.70	105.70	105.70	105.70
1991	55.56	61.46	57.55	54.07	63.45	59.97	56.06	61.96
1992	88.42	95.49	88.60	88.01	95.88	94.93	88.14	95.28
1993	65.68	82.02	67.49	64.15	83.73	80.58	66.00	82.32
1994	81.11	98.47	81.62	80.53	99.34	97.62	80.99	98.46
1995	68.25	97.63	69.82	66.85	99.08	96.35	68.46	97.81
PAD								
1990	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41
1991	6.63	7.23	6.86	6.54	7.47	7.14	6.77	7.38
1992	9.75	10.50	9.80	9.76	10.57	10.49	9.80	10.56
1993	7.28	8.99	7.50	7.18	9.19	8.89	7.40	9.10
1994	8.69	10.51	8.77	8.68	10.63	10.48	8.76	10.60
1995	7.20	10.27	7.39	7.12	10.45	10.19	7.31	10.37

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991
Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

Table 5 (continued)
Forecasts Using the U.S. Apple Industry Model

Scenarios[1]	1	2	3	4	5	6	7	8
	Population Income	Population Income Acreage	Population Income Fresh Exports	Population Income Import Price	Population Income Acreage Fresh Exports	Population Income Acreage Import Price	Population Income Fresh Exports Import Price	Population Income Acreage Fresh Exports Import Price
Variables								
NIJ								
1990	11.837	11.837	11.837	11.837	11.837	11.837	11.837	11.837
1991	11.147	11.358	11.147	11.285	11.358	11.496	11.285	11.496
1992	11.763	12.088	11.725	11.922	12.052	11.244	11.883	12.209
1993	11.015	11.630	11.010	11.152	11.622	11.770	10.148	11.762
1994	11.171	11.914	11.136	11.330	11.885	12.068	10.294	12.038
1995	10.608	11.741	10.596	10.748	11.725	11.884	10.737	11.869

1 Population = Increase of 1.02 % per year
Acreage = Held at 1990 levels
Import Price = Fixed 10% decrease in 1991
Income = Increase of 1.01 % per year
Fresh Exports = Fixed 10 % increase in 1991

With the increase in apple production in 1991, more apples are allocated to the fresh (QPUF) and processed markets (QPUP). However, the percentage of apples utilized for the fresh market (QPUF) remains constant at 55 percent of total production (QPT) from 1991 through 1995. There is an increase from 57.6 to 59.3 in the percentage of processed apples used for juice (QPUJ) from 1991 to 1995. Some of these juice apples come from the canned market (QPUC), as that market share of total processed products decreases from 29.4 percent in 1991 to 28.3 percent in 1995. Both processed apple prices (PPD) and fresh apple prices (PFD) are cyclical from 1991 through 1995 as they were during the sample period. The ratio of fresh prices (PFD) to processed prices (PPD) remains approximately 0.15 during the 5 years of simulation. The quantity of juice imports (NIJ) decreases from 11.8 pounds/person in 1991 to 10.6 pounds per person in 1995 in response to population increases, acreage increases, production fluctuations and price changes.

Scenario 2: Population and Income and Acreage

When acreage is held at 1990 values, there is a smaller increase in total production (QPT) when compared to Scenario 1. The 1995 total production (QPT) is 1,529 million pounds less when acreage is held constant. However, 55 percent of the total production still goes to the fresh market (QPUF). The quantity of apples allocated to the canned market (QPUC) is less when compared to Scenario 1. However, about 30 percent of all processed products goes to the canned market in this scenario. The juice market (QPUJ) receives a slightly smaller market share than in Scenario 1. Fresh apple prices (PFD) and processed apple prices (PPD) remain somewhat stronger in this scenario, yet maintain a ratio of 0.15 during the simulation. Due to lower production levels and less product going to the juice market, juice imports (NIJ) are nearly a pound per person higher in this scenario when compared to Scenario 1.

Scenario 3: Population and Income and Fresh Exports

An expansion of fresh apple exports may be one way to reduce the vulnerability of the apple industry to increasing juice imports. A 10 percent increase in fresh exports (NIF) in 1991 generates an increase in the price for fresh apples (PFD) and processed apple products (PPD). Price increases in apple products (PAD) generate higher production (QPT) and more apples allocated to the fresh market (QPUF) and processed markets (QPUP). In this scenario, prices of frozen (PRD), canned (PCD), juice (PJD) and fresh (PFD) apples are stronger than in Scenario 1. More apples are produced (QPT), yet acreage

(AB) remains at Scenario 1 values, due to lags in the system.

Scenario 4: Population and Income and Import Price

Decreasing prices of juice imports (PIJD) makes juice imports (NIJ) more attractive. In the scenario, there is an increase in the per capita quantity of juice imports (NIJ) when compared to Scenario 1. Increasing imports, puts downward pressure on juice price (PJD). Hence, the price of juice in 1995 is 2.8 percent lower than in Scenario 1. Lower juice prices and prices of all apple products (PAD) yield smaller production of apples (QPT) and smaller quantities of apples allocated to the fresh market (QPUF) and processed markets (QPUP). In 1995, the percent of processed apples allocated to the juice market (QPUJ) remains about 59 percent, as in Scenario 1.

Scenario 5: Population and Income, Acreage and Fresh Exports

When a scenario of population growth, income growth, and constant acreage (AB) is combined with an increase in fresh exports, there is an increase of 21.3 million pounds in total production (QPT) as evidenced by a comparison of Scenarios 2 and 5 in Table 5. More apples are allocated to the fresh market (QPUF) and processed markets (QPUP). In this scenario, prices of apple products (PAD) are higher than in Scenario 2. In 1995, prices of fresh apples (PFD) are nearly 2 percent higher and prices of processed apples (PPD) are nearly 1.5 percent higher.

Scenario 6: Population and Income, Acreage and Import Price

Under this scenario, the decrease in price of juice imports (PIJD) coupled with constant acreage (AB) generates a decrease of more than 12 percent in the total apples produced (QPT) by 1995 as seen by a comparison of Scenarios 6 and 4. Fewer apples are allocated to the fresh market (QPUF) and each of the processed markets (QPUP). Yet, the percentage of processed apples that go to the juice market (QPUJ) increases from 0.52 in Scenario 4 to 0.56 in Scenario 6. The prices of all apple products (PAD) are stronger when the import price decreases (PIJD) and apple acreage (AB) remains at 1990 levels.

Scenario 7: Population and Income, Fresh Exports and Import Price

In this scenario, the impacts of lower juice import prices (PIJD) are mitigated somewhat by increases in fresh exports (NIF). When an increase in fresh exports (NIF) is coupled with a decrease in the juice import price (PIJD) the quantity of juice imports (NIJ) is lower as seen by a comparison of Scenarios 7 and 4 in Table 5. Prices of fresh apples (PFD) and processed apple products (PPD) are stronger due to increased demand for fresh apples. The 1995 quantity allocated to the fresh market (QPUF) is 9 million pounds greater in Scenario 7 than in Scenario 4. However, the relative share of the fresh market to total production remains at 55 percent.

Scenario 8: Population and Income, Acreage, Fresh Exports and Import Price

The final scenario combines all previous assumptions. As expected, the constant acreage (AB) provides some limits on apple production (QPT). Hence, this scenario's apple production is less than if acreage were not controlled as in Scenario 7. The increase in fresh exports (NIF) generates demand for fresh apples, increases the quantity allocated to the fresh market (QPUF) and strengthens the price of fresh apples (PFD) as seen by a comparison of Scenarios 8 and 6. The lower price of juice imports (PIJD) leads to an increase in the quantity of juice imported (NIJ) and a decrease in the quantity of processed apples allocated to the juice market (QPUJ). Furthermore, a comparison of Scenarios 8 and 5 indicate that a decrease in the juice import price (PIJD) weakens the price received for juice (PJD) and the average price for all apple products (PAD).

SUMMARY AND CONCLUSIONS

The dynamic national apple industry model presented here includes relationships for bearing acres, production, utilization and allocation to the fresh, canned, frozen, juice, dried and other markets. Demand in each of the markets are modeled. Data from 1971 through 1990 are used in the estimation of the model. Zellner's seemingly unrelated regression procedure is used since each model sector was considered independent of the other model sectors.

All estimated model equations have coefficients consistent with the hypothesized signs and of reasonable magnitudes. Demand and supply elasticities evaluated at the mean of the data set indicate that changes in acreage are very inelastic with respect to price. The products' elasticities of supply, reflected by the allocation elasticities, are inelastic for all products. Demand flexibilities suggest the demand for fresh apples and apple juice are inelastic while the demand for canned, dried, frozen and other apples are elastic. Fresh, canned, juice and frozen apples are normal goods as indicated by their income flexibilities. Cross-price elasticities suggest that several apple products are substitutes. Static and dynamic simulations were used in model validation. Dynamic simulation errors were slightly higher than static simulation errors. Yet, both lend support to using the model to analyze changes in the industry.

Simulation analysis was used to analyze the impacts of exogenous changes on the performance of the apple industry. The base case assumes that (1) population continues to increase at a rate consistent with the last five years of the sample, (2) income increases at a rate consistent with the last five years of the sample, (3) net imports of all apple products, with the exception of juice, remain at 1990 values, and (4) any long term changes in the industry reflected by trend variables in the model continue for the duration of the analysis. The base case was compared with seven different scenarios where either acreage was assumed to remain at 1990 levels, fresh exports were increased 10 percent in 1991, and/or the price of juice imports decreased 10 percent in 1991. These scenarios indicate that constant acreage provides limits on apple production and thus strengthens prices of apple products. The increase in fresh exports generates demand for fresh apples, increases the quantity allocated to the fresh market and strengthens the price of fresh apples. The lower price of juice imports leads to an increase in the quantity of juice imported and a decrease in the quantity of processed apples allocated to the juice market. Furthermore, a decrease in the import price weakens the juice price and the average price of all apple products.

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APPENDIX A

DATA

APPENDIX A: DATA

	GNP Deflator DEF 1982=100	Population POP mil	PCE-food PCED bil 1982$
1960	30.9		
1961	31.2		
1962	31.9		
1963	32.4		
1964	32.9		
1965	33.8		
1966	35.0		
1967	35.9		
1968	37.7		
1969	39.8		
1970	42.0	205.052	334.5
1971	44.4	207.661	335.9
1972	46.5	209.896	344.2
1973	49.5	211.909	340.8
1974	54.0	213.854	336.6
1975	59.3	215.973	346.4
1976	63.1	218.035	363.6
1977	67.3	220.239	377.1
1978	72.2	222.585	379.6
1979	78.6	225.055	387.5
1980	85.7	227.757	394.9
1981	94.0	230.138	392.5
1982	100.0	232.520	398.8
1983	103.9	234.799	414.0
1984	107.7	237.001	422.8
1985	110.9	239.279	435.5
1986	113.8	241.625	447.1
1987	117.4	243.942	454.0
1988	121.3	246.328	462.2
1989	126.3	248.781	462.9
1990	131.5	251.523	457.5

APPENDIX A: DATA (continued)

	Bearing Acres AB thsnd acres	Index of Prices Paid by Farmers IPP 1982=100	Yield Acre Y thsnd lbs/acre
1960		29	
1961		29	
1962		30	
1963		30	
1964		30	
1965		30	
1966		31	
1967		31	
1968		31	
1969	402.4	33	
1970	402.5	35	15.9
1971	402.2	36	15.8
1972	405.2	39	14.5
1973	399.1	45	15.7
1974	396.0	51	16.6
1975	395.6	56	19.0
1976	403.2	60	16.1
1977	403.4	63	16.7
1978	404.3	68	18.8
1979	407.6	77	19.9
1980	412.2	87	21.4
1981	414.9	94	18.7
1982	418.3	100	19.4
1983	424.5	101	19.7
1984	422.9	103	19.7
1985	430.7	102	18.4
1986	442.4	100	17.8
1987	452.3	102	23.7
1988	463.6	107	19.7
1989	479.0	112	20.8
1990	485.5	116	20.0

APPENDIX A: DATA (continued)

	Total Production QPT mil lbs	Utilized Production QPU mil lbs	Fresh Utilization QPUF mil lbs	Processed Utilization QPUP mil lbs
1970	6397.7	6258.4	3531.5	2726.9
1971	6373.2	6082.7	3483.9	2598.8
1972	5878.8	5867.5	3342.0	2525.5
1973	6265.0	6251.5	3539.4	2712.1
1974	6579.7	6529.8	3690.5	2839.3
1975	7530.0	7102.6	4357.0	2745.6
1976	6472.2	6466.9	3915.8	2551.1
1977	6739.6	6710.0	3859.6	2850.4
1978	7596.9	7544.0	4210.4	3333.6
1979	8126.1	8101.2	4288.6	3812.6
1980	8818.4	8800.4	4934.1	3866.3
1981	7739.6	7692.9	4442.2	3250.7
1982	8122.0	8110.2	4536.7	3573.5
1983	8378.5	8357.9	4620.5	3737.4
1984	8324.0	8309.1	4654.6	3654.5
1985	7914.5	7826.8	4221.7	3605.1
1986	7859.0	7833.3	4463.6	3369.7
1987	10742.1	10451.3	5610.1	4841.2
1988	9128.0	9078.4	5238.3	3840.1
1989	9962.8	9917.4	5865.3	4052.1
1990	9696.8	9658.2	5551.0	4107.2

APPENDIX A: DATA (continued)

	Canned Utilization QPUC mil lbs	Juice & Cider Utilization QPUJ mil lbs	Frozen Utilization QPUR mil lbs	Dried Utilization QPUD mil lbs	Other Utilization QPUO mil lbs
1970	1158.5	1031.7	203.0	189.8	143.9
1971	1093.5	1087.0	190.5	96.2	131.6
1972	976.9	1028.6	235.3	148.6	136.1
1973	1255.4	822.2	259.2	247.7	127.6
1974	1225.6	1030.7	181.7	197.2	204.1
1975	1026.7	1191.6	206.6	229.5	91.2
1976	919.9	1109.1	220.4	229.3	72.4
1977	1075.9	1267.2	160.9	225.5	120.9
1978	1224.2	1494.6	207.4	221.0	186.4
1979	1336.7	1953.8	136.6	255.7	129.8
1980	1202.4	2136.9	167.5	194.7	164.8
1981	1002.4	1798.4	172.7	190.0	87.2
1982	1248.6	1807.8	190.8	209.9	116.4
1983	1204.4	1984.7	169.6	283.3	95.4
1984	1176.7	1888.8	198.1	288.6	102.3
1985	1255.4	1839.1	194.3	242.4	73.9
1986	1179.0	1643.1	257.3	199.4	90.9
1987	1305.8	2928.8	249.1	283.8	73.7
1988	1399.1	1823.6	265.7	285.0	66.7
1989	1320.4	2071.1	321.5	282.4	56.7
1990	1395.8	2075.8	306.3	260.3	69.0

APPENDIX A: DATA (continued)

	Average Grower Price-All PA c/lb	Average Grower Price-Fresh PF c/lb	Average Grower Price-Processing PP $/ton
1960	4.79		
1961	4.09		
1962	4.28		
1963	4.07		
1964	3.86		
1965	4.32		
1966	4.47		
1967	5.57		
1968	6.11		
1969	4.06		
1970	4.54	6.53	39.20
1971	4.92	6.97	43.40
1972	6.43	8.92	62.80
1973	8.80	10.70	125.00
1974	8.40	11.10	96.10
1975	6.50	8.80	56.80
1976	9.10	11.50	108.00
1977	10.60	13.80	122.00
1978	10.40	13.90	117.00
1979	10.90	15.40	114.00
1980	8.70	12.10	84.00
1981	11.10	15.40	102.00
1982	10.00	13.20	118.00
1983	10.50	14.80	104.00
1984	11.10	15.50	112.00
1985	11.70	17.30	103.00
1986	13.40	19.10	116.00
1987	8.60	12.70	79.30
1988	12.70	17.40	123.00
1989	10.40	13.90	107.00
1990	15.00	20.90	139.00

APPENDIX A: DATA (continued)

	Average Grower Price-Canned PC $/ton	Average Grower Price-Juice-Cider PJ $/ton	Average Grower Price-Frozen PR $/ton	Average Grower Price-Dried PD $/ton	Average Grower Price-Other PO $/ton
1970	47.90	27.90	53.40	33.2	37.3
1971	49.40	36.10	52.20	45.4	37.5
1972	67.40	55.70	76.00	68.6	42.4
1973	131.00	98.20	171.00	104.0	103.0
1974	123.00	64.70	121.00	99.7	64.8
1975	57.50	52.60	73.10	65.5	47.4
1976	120.00	91.60	143.00	105.0	114.0
1977	133.00	109.00	138.00	132.0	112.0
1978	119.00	110.00	126.00	154.0	115.0
1979	125.00	103.00	133.00	135.0	110.0
1980	97.40	73.70	112.00	78.7	91.0
1981	121.00	87.90	160.00	77.1	109.0
1982	132.00	103.00	143.00	132.0	123.0
1983	117.00	88.90	161.00	106.0	116.0
1984	137.00	88.20	151.00	123.0	133.0
1985	132.00	74.60	139.00	132.0	117.0
1986	132.00	96.50	150.00	123.0	125.0
1987	118.00	57.80	132.00	67.7	99.9
1988	152.00	95.70	164.00	106.0	131.0
1989	141.00	78.80	158.00	95.2	134.0
1990	166.00	117.00	173.00	125.0	143.0

APPENDIX A: DATA (continued)

	Average Grower Price-All PAD 82c/lb	Average Grower Price-Fresh PFD 82c/lb	Average Grower Price-Processing PPD 82$/ton
1960	15.50		
1961	13.11		
1962	13.42		
1963	12.56		
1964	11.73		
1965	12.78		
1966	12.77		
1967	15.52		
1968	16.21		
1969	10.20		
1970	10.81	15.55	93.33
1971	11.08	15.70	97.75
1972	13.83	19.18	135.05
1973	17.78	21.62	252.53
1974	15.56	20.56	177.96
1975	10.96	14.84	95.78
1976	14.42	18.23	171.16
1977	15.75	20.51	181.28
1978	14.40	19.25	162.05
1979	13.87	19.59	145.04
1980	10.15	14.12	98.02
1981	11.81	16.38	108.51
1982	10.00	13.20	118.00
1983	10.11	14.24	100.10
1984	10.31	14.39	103.99
1985	10.55	15.60	92.88
1986	11.78	16.78	101.93
1987	7.33	10.82	67.55
1988	10.47	14.34	101.40
1989	8.23	11.01	84.72
1990	11.41	15.89	105.70

APPENDIX A: DATA (continued)

	Average Grower Price-Canned PCD 82$/ton	Average Grower Price-Juice-Cider PJD 82$/ton	Average Grower Price-Frozen PRD 82$/ton	Average Grower Price-Dried PDD 82$/ton	Average Grower Price-Other POD 82$/ton
1970	114.05	66.43	127.14	79.05	88.81
1971	111.26	81.31	117.57	102.25	84.46
1972	144.95	119.78	163.44	147.53	91.18
1973	264.65	198.38	345.45	210.10	208.08
1974	227.78	119.81	224.07	184.63	120.00
1975	96.96	88.70	123.27	110.46	79.93
1976	190.17	145.17	226.62	166.40	180.67
1977	197.62	161.96	205.05	196.14	166.42
1978	164.82	152.35	174.52	213.30	159.28
1979	159.03	131.04	169.21	171.76	139.95
1980	113.65	86.00	130.69	91.83	106.18
1981	128.72	93.51	170.21	82.02	115.96
1982	132.00	103.00	143.00	132.00	123.00
1983	112.61	85.56	154.96	102.02	111.65
1984	127.21	81.89	140.20	114.21	123.49
1985	119.03	67.27	125.34	119.03	105.50
1986	115.99	84.80	131.81	108.08	109.84
1987	100.51	49.23	112.44	57.67	85.09
1988	125.31	78.90	135.20	87.39	108.00
1989	111.64	62.39	125.10	75.38	106.10
1990	126.24	88.97	131.56	95.06	108.75

APPENDIX A: DATA (continued)

	Per Cap Util w/ Net Imports Canned QUC lb/person	Per Cap Util w/ Net Imports Juice QUJ lb/person	Per Cap Util w/ Net Imports Frozen QUR lb/person	Per Cap Util w/ Net Imports Dry QUD lb/person	Per Cap Util w/ Net Imports Other QUO lb/person
1970	5.64	6.36	0.98	0.90	0.70
1971	5.27	7.02	0.91	0.48	0.63
1972	4.67	5.44	1.12	0.64	0.65
1973	5.97	4.63	1.22	1.12	0.60
1974	5.75	5.91	0.85	0.91	0.95
1975	4.75	6.87	0.95	1.04	0.42
1976	4.26	6.30	1.01	1.07	0.33
1977	4.88	7.87	0.73	0.99	0.55
1978	5.51	9.57	0.93	0.99	0.83
1979	5.92	10.63	0.60	1.11	0.57
1980	5.27	13.01	0.73	0.82	0.72
1981	4.35	11.53	0.75	0.82	0.38
1982	5.37	14.58	0.82	0.85	0.50
1983	5.13	15.83	0.72	1.21	0.41
1984	5.01	18.40	0.83	1.26	0.43
1985	5.26	18.42	0.81	1.15	0.31
1986	4.91	18.18	1.06	0.83	0.38
1987	5.38	19.43	1.02	1.21	0.30
1988	5.71	19.14	1.08	1.21	0.27
1989	5.34	17.42	1.29	1.11	0.23
1990	5.57	20.09	1.22	0.83	0.27

APPENDIX A: DATA (continued)

	Per Cap Util w/ Net Imports Fresh QUF lb/person	Per Cap Util +Imp-Exp Total QUT lb/person	Orange Fresh Per Capita Consumption QUFO pounds/person	FCOJ Per Capita Consumption QUJO pounds/person
1970	17.02	31.59	16.16	20.73
1971	16.42	30.73	15.72	24.22
1972	15.53	28.03	14.48	27.71
1973	16.13	29.66	14.44	26.86
1974	16.40	30.77	14.42	29.47
1975	19.49	33.52	15.88	32.78
1976	17.08	30.05	14.74	34.33
1977	16.52	31.54	13.44	34.12
1978	18.00	35.82	13.45	27.53
1979	17.24	36.08	12.61	30.31
1980	19.25	39.8	15.84	31.76
1981	17.23	35.04	13.59	30.14
1982	17.68	39.8	12.73	33.28
1983	18.49	41.79	16.12	38.85
1984	18.63	44.56	12.81	33.49
1985	17.52	43.48	12.31	36.24
1986	18.16	43.52	14.53	39.83
1987	21.34	48.69	14.01	35.92
1988	19.97	47.39	14.68	37.36
1989	21.57	46.96	13.41	30.17
1990	19.80	47.79	13.38	25.10

APPENDIX A: DATA (continued)

	Trend T	Dummy for 1973-74 D734	Dummy for 1976-79 D769
1970	0	0	0
1971	1	0	0
1972	2	0	0
1973	3	1	0
1974	4	1	0
1975	5	0	0
1976	6	0	1
1977	7	0	1
1978	8	0	1
1979	9	0	1
1980	10	0	0
1981	11	0	0
1982	12	0	0
1983	13	0	0
1984	14	0	0
1985	15	0	0
1986	16	0	0
1987	17	0	0
1988	18	0	0
1989	19	0	0
1990	20	0	0

APPENDIX A: DATA (continued)

	Fresh/Process Price Ratio PFDPPD (dimensionless)	Can/Process Price Ratio PCDPPD (dimensionless)	Juice/Process Price Ratio PJDPPD (dimensionless)	Dried/Process Price Ratio PDDPPD (dimensionless)	Other/Process Price Ratio PODPPD (dimensionless)
1970	0.167	1.222	0.712	0.847	0.952
1971	0.161	1.138	0.832	1.046	0.864
1972	0.142	1.073	0.887	1.092	0.675
1973	0.086	1.048	0.786	0.832	0.824
1974	0.116	1.280	0.673	1.037	0.674
1975	0.155	1.012	0.926	1.153	0.835
1976	0.106	1.111	0.848	0.972	1.056
1977	0.113	1.090	0.893	1.082	0.918
1978	0.119	1.017	0.940	1.316	0.983
1979	0.135	1.096	0.904	1.184	0.965
1980	0.144	1.160	0.877	0.937	1.083
1981	0.151	1.186	0.862	0.756	1.069
1982	0.112	1.119	0.873	1.119	1.042
1983	0.142	1.125	0.855	1.019	1.115
1984	0.138	1.223	0.788	1.098	1.188
1985	0.168	1.282	0.724	1.282	1.136
1986	0.165	1.138	0.832	1.060	1.078
1987	0.160	1.488	0.729	0.854	1.260
1988	0.141	1.236	0.778	0.862	1.065
1989	0.130	1.318	0.736	0.890	1.252
1990	0.150	1.194	0.842	0.899	1.029

APPENDIX A: DATA (continued)

	Net Imports Fresh NIF lbs/person	Net Imports Canned NIC lbs/person	Net Imports Frozen NIR lbs/person	Net Imports Dried NID lbs/person	Net Imports Other NIO lbs/person
1970	-0.202	-0.010	-0.010	-0.026	-0.002
1971	-0.357	0.004	-0.007	0.017	-0.004
1972	-0.392	0.016	-0.001	-0.068	0.002
1973	-0.572	0.046	-0.003	-0.049	-0.002
1974	-0.857	0.019	0.000	-0.012	-0.004
1975	-0.684	-0.004	-0.007	-0.023	-0.002
1976	-0.880	0.041	-0.001	0.018	-0.002
1977	-1.005	-0.005	-0.001	-0.034	0.001
1978	-0.916	0.010	-0.002	-0.003	-0.007
1979	-1.816	-0.019	-0.007	-0.026	-0.007
1980	-2.414	-0.009	-0.005	-0.035	-0.004
1981	-2.072	-0.006	0.000	-0.006	0.001
1982	-1.831	0.000	-0.001	-0.053	-0.001
1983	-1.189	0.001	-0.002	0.003	0.004
1984	-1.010	0.045	-0.006	0.042	-0.002
1985	-0.123	0.013	-0.002	0.137	0.001
1986	-0.313	0.031	-0.005	0.005	0.004
1987	-1.658	0.027	-0.001	0.047	-0.002
1988	-1.296	0.030	0.001	0.053	-0.001
1989	-2.006	0.033	-0.002	-0.025	0.002
1990	-2.270	0.021	0.002	-0.205	-0.004

APPENDIX A: DATA (continued)

	Net Imports Juice NIJ lbs/person	Net Imports Juice Total NIJT thsnd gallons	Net Imports Juice Value NIV thsnd $	Net Imports Juice Price PIJ $/gallon	Net Imports Juice Price PIJD 1982$/gallon
1970	1.329	16,800	4,081	0.24	0.58
1971	1.786	34,024	8,775	0.26	0.58
1972	0.539	25,566	8,599	0.34	0.72
1973	0.750	20,644	13,675	0.66	1.34
1974	1.090	21,496	11,277	0.52	0.97
1975	1.353	21,216	8,222	0.39	0.65
1976	1.213	34,388	13,651	0.40	0.63
1977	2.116	31,907	24,891	0.78	1.16
1978	2.855	44,364	36,990	0.83	1.15
1979	1.949	66,501	66,916	1.01	1.28
1980	3.628	43,521	40,066	0.92	1.07
1981	3.716	81,547	60,227	0.74	0.79
1982	6.805	103,688	92,334	0.89	0.89
1983	7.377	149,194	112,056	0.75	0.72
1984	10.430	167,747	122,276	0.73	0.68
1985	10.734	214,296	136,949	0.64	0.58
1986	11.380	224,553	191,853	0.85	0.75
1987	7.424	226,215	183,103	0.81	0.69
1988	11.737	195,519	166,149	0.85	0.70
1989	9.095	218,668	170,370	0.78	0.62
1990	11.837	238,338	175,151	0.73	0.56

APPENDIX B

SOURCES OF DATA

APPENDIX B: SOURCES OF DATA

AB	Bearing Acres	(thousand acres)
	1969: Johnson, Doyle C. Fruits and Nuts Bearing Acreage, 1947-83. USDA/NASS Statistical Bulletin Number 761. December 1987. Table 3.	
	1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 3. Page 10.	
	1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 3. Page 17.	
D734	Dummy Variable for 1973-74 (1971-72=0, 1973-74=1, 1975-91=0)	
D769	Dummy Variable for 1976-79 (1971-75=0, 1976-79=1, 1980-91=0)	
DEF	GNP Deflator	(1982 = 100)
	1960-89: Economic Report of the President 1990, Table C-3	
	1990: Economic Report of the President 1991, Table B-3	
IPP	Index of Prices Paid by Farmers	(1977=100)
	1960-64: Agricultural Statistics 1967	or (1982=100)
	1965-69: Agricultural Statistics 1977	
	1970-72: Agricultural Statistics 1981	
	1973-74: Agricultural Statistics 1988	
	1975-87: Agricultural Statistics 1990	
	1988-90: Agricultural Statistics 1991	
NIC	Net Imports - Canned	(lbs/person)
	NIC=QUC-QPUC/POP	
NID	Net Imports - Dried	(lbs/person)
	NID=QUD-QPUD/POP	
NIF	Net Imports - Fresh	(lbs/person)
	NIF=QUF-QPUF/POP	
NIJ	Net Imports - Juice	(lbs/person)
	NIJ=QUJ-QPUJ/POP	
NIJT	Net Imports - Juice Total	(thousand gallons)
	TSUSA #1651500 Apple/Pear Juice not over 1% alcohol	
	1970: Foreign Agricultural Trade of the United States Calendar Year Supplement 1970.	
	1971: Foreign Agricultural Trade of the United States Calendar Year Supplement 1972.	
	1972: Foreign Agricultural Trade of the United States Calendar Year Supplement 1973.	
	1973: Foreign Agricultural Trade of the United States Calendar Year Supplement 1974.	

APPENDIX B: SOURCES OF DATA (continued)

1974: Foreign Agricultural Trade of the United States Calendar Year Supplement 1975.
1975: Foreign Agricultural Trade of the United States Calendar Year Supplement 1976.
1976: Foreign Agricultural Trade of the United States Calendar Year Supplement 1977.
1977: Foreign Agricultural Trade of the United States Calendar Year Supplement 1978.
1978: Foreign Agricultural Trade of the United States Calendar Year Supplement 1979.
1979: Foreign Agricultural Trade of the United States Calendar Year Supplement 1980.
1980: Foreign Agricultural Trade of the United States Calendar Year Supplement 1981.
1981: Foreign Agricultural Trade of the United States Calendar Year Supplement 1982.
1982: Foreign Agricultural Trade of the United States Calendar Year Supplement 1984.
1983-85: Foreign Agricultural Trade of the United States Calendar Year Supplement 1985.
1986-88: Foreign Agricultural Trade of the United States Calendar Year Supplement 1989.
Harmonized Import Commodity 2009700000, 2009700010, 2009700020, 2009700090, 2009802000
1989-90: Foreign Agricultural Trade of the United States Calendar Year Supplement 1990.

NIO Net Imports - Other (lbs/person)
NIO=QUO-QPUO/POP

NIR Net Imports - Frozen (lbs/person)
NIR=QUR-QPUR/POP

NIV Net Import - Juice Value (thousand dollars)
TSUSA #1651500 Apple/Pear Juice not over 1% alcohol
1970: Foreign Agricultural Trade of the United States Calendar Year Supplement 1970.
1971: Foreign Agricultural Trade of the United States Calendar Year Supplement 1972.
1972: Foreign Agricultural Trade of the United States Calendar Year Supplement 1973.
1973: Foreign Agricultural Trade of the United States Calendar Year Supplement 1974.
1974: Foreign Agricultural Trade of the United States Calendar Year Supplement 1975.
1975: Foreign Agricultural Trade of the United States Calendar Year Supplement 1976.
1976: Foreign Agricultural Trade of the United States Calendar Year Supplement 1977.

APPENDIX B: SOURCES OF DATA (continued)

	1977: Foreign Agricultural Trade of the United States Calendar Year Supplement 1978.
	1978: Foreign Agricultural Trade of the United States Calendar Year Supplement 1979.
	1979: Foreign Agricultural Trade of the United States Calendar Year Supplement 1980.
	1980: Foreign Agricultural Trade of the United States Calendar Year Supplement 1981.
	1981: Foreign Agricultural Trade of the United States Calendar Year Supplement 1982.
	1982: Foreign Agricultural Trade of the United States Calendar Year Supplement 1984.
	1983-85: Foreign Agricultural Trade of the United States Calendar Year Supplement 1985.
	1986-88: Foreign Agricultural Trade of the United States Calendar Year Supplement 1989.
	Harmonized Import Commodity 2009700000, 2009700010, 2009700020, 2009700090, 2009802000
	1989-90: Foreign Agricultural Trade of the United States Calendar Year Supplement 1990.
PA	Average Grower Price - All (cents/lb) 1960-69: Agricultural Statistics 1977 1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18. 1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.
PAD	Average Grower Price - All (1982 cents/lb) PAD=PA/DEF*100
PC	Average Grower Price - Canned ($/ton) 1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18. 1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.
PCD	Average Grower Price - Canned (1982 $/ton) PCD=PC/DEF*100
PCDPPD	Average Grower Price Ratio - Canned to Process (dimensionless) PCDPPD=PCD/PPD
PCED	Personal Consumption Expenditure for Food (billion 1982$) 1970-86: Economic Report of the President 1990, Table C-15 1987-90: Economic Report of the President 1991, Table B-15

APPENDIX B: SOURCES OF DATA (continued)

PD — Average Grower Price - Dried ($/ton)
1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.

PDD — Average Grower Price - Dried (1982 $/ton)
PDD=PD/DEF*100

PDDPPD — Average Grower Price Ratio - Dried to Process (dimensionless)
PDDPPD=PDD/PPD

PF — Average Grower Price - Fresh (cents/lb)
1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.

PFD — Average Grower Price - Fresh (1982 cents/lb)
PFD=PF/DEF*100

PFDPPD — Average Grower Price Ratio - Fresh to Process (dimensionless)
PFDPPD=PFD/PPD

PIJ — Average Import Price - Juice ($/gallon)
PIJ=NIV/NIJT

PIJD — Average Import Price - Juice (1982$/gallon)
PIJD=PIJ/DEF*100

PJ — Average Grower Price - Juice and Cider ($/ton)
1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.

PJD — Average Grower Price - Juice and Cider (1982 $/ton)
PJD=PJ/DEF*100

PJDPPD — Average Grower Price Ratio - Juice to Process (dimensionless)
PJDPPD=PJD/PPD

APPENDIX B: SOURCES OF DATA (continued)

PO	Average Grower Price - Other	($/ton)
	1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.	
	1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.	
POD	Average Grower Price - Other	(1982 $/ton)
	POD=PO/DEF*100	
PODPPD	Average Grower Price Ratio - Other to Process	(dimensionless)
	PODPPD=POD/PPD	
POP	Population	(million)
	1970-86: Economic Report of the President 1990, Table C-31	
	1987-90: Economic Report of the President 1992, Table B-29	
PP	Average Grower Price - Processing	($/ton)
	1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.	
	1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.	
PPD	Average Grower Price - Processing	(1982 $/ton)
	PPD=PP/DEF*100	
PR	Average Grower Price - Frozen	($/ton)
	1970-88: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.	
	1989-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10 and 14. Pages 22 and 24.	
PRD	Average Grower Price - Frozen	(1982 $/ton)
	PRD=PR/DEF*100	
QPT	Total Production	(million pounds)
	1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 10. Page 16.	
	1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 10. Page 22.	

APPENDIX B: SOURCES OF DATA (continued)

QPU — Utilized Production (million pounds)
1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 10. Page 16.
1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 10. Page 22.

QPUC — Canned Utilization (million pounds)
1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.

QPUD — Dried Utilization (million pounds)
1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.

QPUF — Fresh Utilization (million pounds)
1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.

QPUJ — Juice and Cider Utilization (million pounds)
1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.

QPUO — Other Utilization (million pounds)
1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.
1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.

APPENDIX B: SOURCES OF DATA (continued)

QPUP	Processed Utilization	(million pounds)
	1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.	
	1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.	
QPUR	Frozen Utilization	(million pounds)
	1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Tables 10 and 14. Pages 16 and 18.	
	1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Tables 10. Pages 22.	
QUC	Per Capita Utilization with Net Imports - Canned	(pounds/person)
	1970-81: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 109. Page 77.	
	1982-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.	
QUD	Per Capita Utilization with Net Imports - Dry	(pounds/person)
	1970-86: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 109. Page 77.	
	1987-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.	
QUF	Per Capita Utilization with Net Imports - Fresh	(pounds/person)
	1970-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.	
QUFO	Fresh Orange Per Capita Consumption	(pounds/person)
	1970-80: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 77. Page 49.	
	1981-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 107. Page 74.	
QUJ	Per Capita Utilization with Net Imports - Juice	(pounds/person)
	1970-79: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 109. Page 77.	

APPENDIX B: SOURCES OF DATA (continued)

	1980-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.
QUJO	FCOJ Single Strength Per Capita Consumption (pounds/person) 1970-78: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 108. Page 76. 1979-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 114. Page 77.
QUO	Per Capita Utilization with Net Imports - Other (pounds/person) 1970-82: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 109. Page 77. 1983-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.
QUR	Per Capita Utilization with Net Imports - Frozen (pounds/person) 1970-87: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-254 August 1990. Table 109. Page 77. 1988-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.
QUT	Per Capita Utilization with Net Imports - Total (pounds/person) 1970-90: USDA/ERS/CED. Fruit and Tree Nuts Situation and Outlook Report Yearbook. TFS-258 August 1991. Table 115. Page 78.
T	Time Trend (1971=1)
Y	Yield (thousand lbs/acre) Y=QPT/AB

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